

Hydrodynamical Simulations of the Uranian Rings

I. Mosqueira (NASA Ames Research Center), P. R. Estrada (Cornell University),
L. Brookshaw (Lawrence Livermore)

We investigate the global dynamics of the Uranian rings using a modified 2-D smoothed particle hydrodynamic code combined with a 2-D tree code used to compute the particle-to-particle gravitational interactions. This code includes epicyclic fluid motion, non-axisymmetric flow, local and non-local shear viscosity, self-consistent scale height evolution, ring-satellites gravitational interaction and co-evolution, and ring self-gravity. To follow the scale height of each particle we solve the vertical momentum equation for the flow using a Runge-Kutta scheme with a second order polynomial fit to the vertical behavior of the fluid pressure (Borderies, Goldreich, and Tremaine 1985. *Icarus*, **63**, 406). The behavior of the fluid viscosity is obtained from Mosqueira (1996. *Icarus*, **122**, 128) who found good agreement between an extension to the non-local viscosity model of Borderies, Goldreich, and Tremaine (1985) that includes local terms with the results of a local patch-code ring simulation. Our present viscosity model incorporates further terms which account for the epicyclic limit to the mean free path (Goldreich and Tremaine 1978. *Icarus*, **34**, 227). This treatment covers both the high and low ring density regimes. Our approach treats the fluid work terms and internal energy self-consistently even in the presence of a non-zero divergence of the fluid velocity. Even within a 2-D framework the Uranian rings are so thin compared to their semi-major axes that radial resolution requires too many particles given our present computer resources. To address this issue we have developed a physical scaling that reduces the semi-major axis of the ring while preserving its width and, we believe, retains the relevant global satellite-ring dynamics. With a conservative value of the scaling parameter that reduces the ring's semi-major axis by a factor of 10, our scaling allows for savings between a factor of 20 in the case of synodic time scales, a factor of 200 for shear timescales, and a factor of 2000 for viscous timescales. In the present study we use this scaling to test the validity of the self-gravity model of eccentric ring precession (Goldreich and Tremaine 1979. *Astron. J.*, **84**, 1638).

Abstract submitted for 1996 DPS meeting

Date submitted: LPI electronic form version 5/96

Division for Planetary Sciences Abstract Form

DPS Category 17

Running #7433

Session 0.00

Invited ☐ Poster presentation ☒ Title only ☐

Have you received your Ph.D. since the last DPS meeting?

Yes ☐ No ☐

Is your abstract newsworthy, and if so, would you be willing to prepare a news release and be available for interviews with reporters?

Yes ☒ No ☐ Maybe ☐

Paper presented by Ignacio Mosqueira

NASA Ames Research Center

Space Sciences Bldg.

Mail Stop 245-6

Moffett Field CA 94035 USA

Phone: (415) 604-5530

Fax: (415) 604-6779

Email: mosqueir@cosmic.arc.nasa.gov

Special instructions: Tue Aug 27 16:05:52 CDT 1996

Membership Status (First Author):

DPS-AAS Member ☐ Non-Member ☒

Student Member ☐ Student Non-Member ☐

Is this your first DPS presentation? Yes ☒ No ☐

Sponsor: Jeff N. Cuzzi